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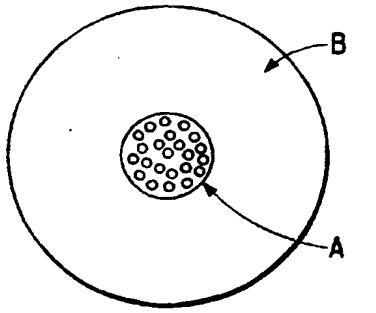
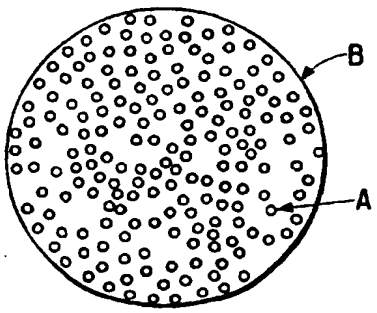
(57) Abstract

Agricultural compositions comprising water-soluble polymeric fibers containing at least one agriculturally active ingredient within the polymer matrix configured into ropes or nets are disclosed.





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TITLE

WATER-SOLUBLE FIBERS AND NETS AS AGRICULTURAL FORMULATIONS

The present invention relates to the use of water-soluble fibers containing agriculturally active ingredients as agricultural formulations. The fibers can be in various embodiments such as solid fibers containing active ingredient dispersed therein, or sheath and core fibers wherein a polymer sheath surrounds a core of active ingredient. The fibers are configured into ropes, nets, or other physical forms.

A sealed water-soluble bag containing agriculturally active ingredients, is disclosed in U.S. 5,080,226 which reduces worker exposure to agriculturally active ingredients, and eliminates the need to dispose of contaminated overwraps. However, water-soluble bags do not provide a means for variable unit packaging. A single agriculturally active ingredient dispersed in a water-soluble polymer sheet, as disclosed in U.S. 3,299,566, addresses the need for variable unit packaging but the dissolution rate of the sheets can be too slow in a water mix tank to meet a grower's needs. Neither of these water-soluble polymer formulations offer improvements over conventionally sprayed formulations in reducing off-target movement (aerial spray drift and movement in the soil) or in avoiding mix tank cleanout concerns.

WO 89/01284 discloses a water-permeable sheet prepared from water-insoluble polymer containing bodies ("buttons" or "beads") of polymer which contain a 2,6-dinitroaniline pesticide. Disposal of the water-permeable sheet is required.

U.S. 3,299,566 discloses dispersion of pesticides within perforated water-soluble sheeting and application of this sheet to the soil. However, the sheet uses excess polymer per unit area and is clumsy and easily blown about by the wind (creating a secondary hazard). Thus, there is a need for an agricultural formulation that provides variable unit packaging, reduces off target movement, avoids mix tank cleanout problems and is easily disposable without creating secondary hazards.

SUMMARY OF THE INVENTION

The present invention comprises an agricultural composition comprising at least one water-soluble polymeric fiber wherein at least one agriculturally active ingredient is contained within the fiber. The fiber can have the agriculturally

active ingredient uniformly dispersed or dissolved therein. Alternatively, the fiber is in the form of a polymeric sheath of at least one layer surrounding a core comprising the agriculturally active ingredient. The polymeric sheath can also contain one or more agriculturally active ingredients, or can comprise multiple layers, each said layer containing at least one agriculturally active ingredient. The agricultural composition of the present invention employing one or both of the above-described fibers is configured into various physical forms. For example, two or more fibers can be configured in the form of a rope or net wherein each fiber contains the same or distinct active ingredients. Thus, incorporation of incompatible active ingredients in one formulation is possible. Further, such nets or ropes can be perforated into unit dosages easily separated for use in desired appropriate quantities. The present invention further comprises water-soluble nets of random or uniform configuration containing agriculturally active ingredients prepared by the creation of voids or holes in water-soluble film incorporating agriculturally active ingredients within the film matrix.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a cross sectional view of one fiber of the present invention wherein A is an agriculturally active ingredient and B is a polymer sheath.

Figure 2 is a cross sectional view of another fiber of the present invention wherein A is an agriculturally active ingredient and B is a polymer matrix.

Figure 3A is a plane view of a woven net of the present invention of uniform configuration.

Figure 3B is a plane view of a net of the present invention of random configuration.

Figure 4 is a scanning electron micrograph of a net of the present invention. The fiber diameter ranges from less than 1 μ to 10 μ.

DETAILED DESCRIPTION OF THE INVENTION

An agricultural composition of the present invention can take the form of a fiber of a polymeric sheath surrounding a core containing the active ingredient. This type of fiber is referred to hereinafter as a "sheath and core" fiber and is illustrated in Figure 1. In addition, the present invention comprises agricultural compositions of fibers wherein the agriculturally active ingredient is homogeneously dissolved and/or dispersed in the polymer which forms a continuous solid matrix. This type of fiber is referred to hereinafter as a "solid filled fiber" and is illustrated in Figure 2.

A "rope" is defined herein as two or more fibers, sheath and core and/or solid filled, intertwined to form a larger cylindrical form wherein the average distance between the fibers is less than the fiber diameter. Fibers containing an agriculturally active ingredient and combinations of such fibers in the form of a rope are useful to safely apply agriculturally active ingredients for either pre- or postemergent treatment. The proper dosage of active ingredient is measured per unit length of fiber or rope. The sheath and core fibers and ropes prepared therefrom without any agriculturally active ingredient in the sheath are especially effective in providing worker safety.

In a preemergent application, one or more fibers or ropes are laid in a furrow during seed planting. For example, the application may be accomplished by unwinding a roll of the fiber(s) or rope behind a groundrig and covering it and the seed with soil. Dissolution of the formulation polymer and release of the active ingredient are accomplished by applying water (by ground rig or irrigation) or by rain. Alternatively, application can be accomplished by "shooting" the fiber or rope from a series of shooting apparatus mounted across a ground rig wherein a number of parallel fibers or ropes are shot onto or into a canopy of plants. Release of the active ingredient is accomplished by spraying water at the same time or after the fibers or ropes are applied.

In a postemergent application, the fiber(s) or rope(s) is metered into a mix tank of water, wherein dissolution occurs quickly because of the high surface area of the fiber(s). The addition to the mix tank is preferably accomplished by "shooting" the fiber or rope from an apparatus, e.g., a hand held "gun," containing rolls of the formulation. The fiber or rope may be propelled pneumatically or by gripping rollers. Preferably, a postemergent application is made in a spray injection system whereby a fiber or rope is conveyed into closed chambers wherein the polymer rapidly dissolves in turbulent water and the agriculturally active ingredient emerges in an aqueous spray, e.g., from an aerial rig. In this way a more closed system than a mix tank is used, and concerns about worker exposure and tank cleanout are reduced. The fibers and ropes of the present invention provide a hitherto unknown way of injecting a solid formulation with uniform metering and rapid dissolution without producing contaminated waste packaging. The fibers or ropes can optionally contain air to aid in floating.

The agricultural composition of the present invention can also be in the form of a net which is defined herein as a plurality of intermingled, overlaid, or

intertwined fibers wherein the average distance between the fibers is equal to or greater than the fiber diameter (i.e., the aspect ratio is greater than or equal to one). The fibers can be in a random or ordered arrangement within the net. Some nets of the present invention are illustrated in Figures 3A, 3B, and 4. Nets can also take the form of a water-soluble filled film which contains a plurality of holes such that the open space of the net is equal to or greater than the solid area. Filled films are sheets of polymeric material having an agriculturally active ingredient dissolved and/or dispersed within the polymer matrix.

The nets are useful to safely apply agriculturally active ingredients for either pre- or postemergent treatment. The proper dosage of agriculturally active ingredient is measured per unit area of net.

For example in a preemergent application, a roll of netting is unwound behind a groundrig onto the surface of the ground after, or preferably during, seed planting. Release of the active ingredient is accomplished by spraying water (optionally with fertilizer and nutrients), by irrigation, or by rain or dew.

In the most preferred postemergent application, a roll of netting is unwound behind a ground rig over the emerging crop. Release of the active ingredient is accomplished by spraying water at the same time the net is unrolled from a ground rig. In this way the partially dissolved, gel-like net is deposited on the foliage. The deposition: (1) aids sticking of the active ingredient to the target area, (2) helps prevent off-target active from reaching the ground, (3) begins release of the active ingredient, and (4) helps anchor the net during unrolling. Spray drift is not a concern, since only water (or water plus fertilizer/nutrient) is sprayed. Narrow nets can be placed between rows for control of pests in regions immediately adjacent to the crop.

Similarly, the fiber nets of the present invention can be spread over individual trees in orchards. Tremendous drift problems are encountered when conventional agricultural compositions are spray blasted onto trees. However, only water is sprayed with the net, and therefore spray drift problems with the agriculturally active ingredients do not exist.

In another postemergent application of the fiber nets of the present invention, unit sheets of nets (e.g., one square meter of net per hectare) are introduced into a mix tank of water and thereafter sprayed in a conventional manner. Alternatively, narrow strips of netting can be metered into a mix tank or injection line and sprayed in a conventional manner. Rapid dissolution is

realized, because of the high surface area of the net. A preferred net for mix tank application comprises a number of fibers filled with air along with the fibers containing the agriculturally active ingredient such that the net floats, and therefore dissolves rapidly. A net which sinks in the mix tank can stick to the bottom and dissolve more slowly.

The compositions of the present invention may be packaged as rolls or sheets contained within water impervious packages. In the case of the sheath and core fibers wherein the sheath lacks an active ingredient, the packages are uncontaminated and require no special means of disposal. For cases wherein the active ingredient may reside uncoated on the surface of the fiber (e.g., the solid filled fibers), water-soluble film linings within the packages may optionally be used. This lining may be added to the mix tank, dissolved and sprayed.

The agriculturally active ingredients which are suitable contents for the fibers of the present invention comprise pesticides such as herbicides, fungicides, insecticides, bactericides, acaricides, and biological pest control agents, as well as plant growth regulators, and formulated compositions thereof. The agriculturally active ingredients can be in the form of liquids, gels, or solids. In short, any chemical or biological active ingredient can be packaged using the fiber delivery system, provided it does not dissolve the water-soluble polymer or become deactivated by the polymer.

Examples of suitable agricultural pesticides include: herbicides such as acifluorfen, asulam, atrazine, bentazon, bromacil, bromoxynil, hydroxybenzonitrile, chloramben, chloroxuron, chlorotuluron, clomazone, cyanazine, dazomet, desmediphan, dicamba, dichlorbenil, dichlorprop, diphenamid, dipropetryn, diuron, thiameturon, fenac, fenuron, fluometuron, fluridone, fomesafen, glyphosate, hexazinone, imazamethabenz, imazaquin, imazethapyr, ioxynil, isoproturon, isouron, isoxaben, karbutilate, lenacil, 4-chloro-2-methyl-phenoxyacetic acid, 4-[(4-chloro-o-tolyl)oxy]butyric acid, mefluidide, methabenzthiauron, methazole, metribuzin, monuron, naptalam, neburon, nitralin, norflurazon, oryzalin, perfluidone, phenmedipham, picloram, prometryn, pronamide, propazine, pyrazon, siduron, simazine, tebuthiuron, terbacil, terbuthylazine, terbutryn, triclopyr, (2,4-dichlorophenoxy)acetic acid, 4-(2,4-dichlorophenoxy)butyric acid, and sulfonylureas such as chlorsulfuron, sulfometuron, chlorimuron ethyl, metsulfuron methyl, methyl 2-[[[[(4,6-dimethoxy-2-pyrimidinyl)-amino]carbonyl]-amino]sulfonyl]-6-(trifluoromethyl)-

3-pyridinecarboxylate, ethametsulfuron methyl, triasulfuron, ethyl 5-[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-amino]sulfonyl]-1-methyl-1*H*-pyrazole-4-carboxylate, *N*-[[(4,6-dimethoxy-2-pyrimidinylamino]carbonyl]-3-(ethylsulfonyl)-2-pyridinesulfonamide, thifensulfuron, tribenuron methyl, bensulfuron methyl, nicosulfuron, methyl 2-[[[[[4,6-bis(difluoromethoxy)-2-pyrimidinyl]amino]carbonyl]amino]sulfonyl]-benzoate, methyl 2-[[[[[4-dimethylamino)-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-yl]amino]-carbonyl]amino]sulfonyl]-3-methylbenzoate, *N*-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-1-methyl-4-(2-methyl-2H-tetrazol-5-yl)-1H-pyrazole-5-sulfonamide, and salts thereof. Examples of suitable fungicides include carbendazim, thiuram, dodine, chloroneb, cymoxanil, captan, folpet, thiophanate-methyl, thiabendazole, chlorothalonil, dichloran, captafol, iprodione, vinclozolin, kasugamycin, thiadimenol, flutriafol, flusilazol, hexaconazole, and fenarimol. An example of a suitable bactericide is oxytetracycline dihydrate. Examples of suitable acaricides include hexathizox, oxythioquinox, dienochlor, and cyhexatin. Examples of suitable insecticides include carbofuran, carbyl, thiodicarb, deltamethrin, and tetrachlorvinphos. Examples of suitable biological pest control agents include Bacillus thuringiensis and baculovirus.

Preferred agriculturally active ingredients are sulfonylurea herbicides and salts thereof.

Each of the types of embodiments may be used to introduce two or more active ingredients, even if they are ordinarily incompatible together in the same formulation, since they are separated from each other in individual strands or layers of polymer. Examples of incompatible pairs of crop protection chemicals which can be used in the present invention include: bensulfuron methyl and molinate; (2,4-dichlorophenoxy)acetic acid and thifensulfuron methyl; (2,4-dichlorophenoxy)acetic acid and methyl 2-[[[[*N*-4-methoxy-6-methyl-1,3,5-triazine-2-yl)-*N*-methylamino]carbonyl]amino]sulfonyl]benzoate; (2,4-dichlorophenoxy)acetic acid and metsulfuron methyl; maneb or mancozeb and benomyl; glyphosate and metsulfuron methyl; tralomethrin and any organophosphate insecticide such as monocrotophos or dimethoate; bromoxynil and *N*-[[4,6-dimethoxypyrimidine-2-yl)amino]carbonyl]-3-(ethylsulfonyl)-2-pyridine-sulfonamide; bromoxynil and methyl 2-[[[[(4-methyl-6-methoxy)-1,3,5-triazin-2-yl)amino]carbonyl]amino]-sulfonyl]benzoate; and bromoxynil and

methyl 2-[[[[[*N*-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-*N*-methylamino]-carbonyl]amino]sulfonyl]benzoate.

The compositions of the present invention employ polymers which are soluble in cold water, fiber-forming, and biodegradable. These properties allow the preparation of the fibers, avoid residual polymers in the soil and facilitate quick release of the active ingredient in the immediate locus of the target area. Cold-water soluble grades of polymers may be used for both pre- and postemergent application. Somewhat slower dissolving polymers and/or thicker fibers may be used in formulations for preemergent application.

Suitable water-soluble polymers include homopolymers or salts or copolymers thereof. Examples of such polymers are polyvinyl alcohol (PVA), polyethylene oxide (PEO), water-soluble substituted cellulose (e.g., hydroxypropyl methylcellulose, methyl cellulose, carboxymethyl cellulose, hydroxyethyl cellulose, carboxy methyl hydroxyethylcellulose), starch, gelatin, polyvinyl pyrrolidone, polyacrylamide, polyacrylic acid, and polymethacrylic acid. PEO and especially PVA are preferred.

The fibers used in the compositions of the present invention optionally contain one or more adjuvants. Adjuvants suitable for use herein are well known in the art and include water-soluble binders, excipients, surfactants, spreader-stickers, defoamers, and water-soluble plasticizers. Polyols are preferred plasticizers for the fiber-forming polymers including polyethylene glycol, glycerol, and nonionic surfactants with long chain ethylene oxide groups.

Solid filled fibers wherein the agriculturally active ingredient(s) is dispersed and/or dissolved in the water-soluble polymer may be prepared by conventional solution- or melt-spinning processes. Both processes are well known in the synthetic fiber industry. The melt-spinning process involves extrusion of a polymer melt through a capillary followed by cooling. The solution spinning process involves extrusion of a solution of the polymer in an inert solvent followed by drying. The melt spinning technique is preferred because a solvent recovery step is avoided and some of the agriculturally active ingredients easily degrade in the presence of solvents (e.g., hot water). In the preferred process, the amount of solvent, the temperature, and the exposure time to solvent are minimized.

Filled sheath and core fibers are prepared by melt-spinning or co-extrusion processes. The multi-layered type of fiber (i.e., those containing concentric or

acentric sheaths) is prepared by co-extrusion. The co-extrusion process is also well known in the synthetic fiber industry. The process involves extrusion of a polymer melt through a capillary which is surrounded by a second stream of polymer melt flowing through an outer co-axial concentric or acentric capillary. The outer capillary can be surrounded by a third stream of polymer melt flowing through a third co-axial capillary. The fiber formed thereby comprises an outer most layer, the outer sheath, an inner sheath beneath the outer sheath, and a central core.

The cores of the sheath and core fibers can be filled with active ingredient alone or active ingredient dispersed and/or dissolved in a water-soluble binder. The binder can be any water-soluble binder normally used for granulation of agriculturally active ingredients (e.g., sugars and ligninsulfonates). Meltable binders, especially low melting binders such as polyethylene oxide or polyethylene glycol, are preferred because solvent removal is not necessary.

Filled fiber nets can be prepared by jet attenuated solution spinning, drying the fibers in a current of hot air, and directly layering the fibers in the form of a net over a screen or conveyor belt, as described in U.S. 4,963,298 herein incorporated by reference. Alternatively, the nets can by prepared by conventional means such as weaving or knitting.

The amount of agriculturally active ingredient(s) in the fibers range from about 0.0001 to about 50 weight percent, based on the total weight of the composition. The preferred amount for fibers targeted for direct application is from about 0.0001 to about 5 weight percent, while a range from about 5 to about 50 weight percent is preferred for fibers to be applied using mix tank or injection methods. At least 35 weight percent polymer, based on the total weight of the composition, is required for fiber integrity.

Fiber diameters may range from about 1 micron to about 1 cm. A diameter range from about 1 micron to about 0.25 mm is preferred for fibers applied by mix tank or injection methods in order to speed dissolution. A fiber diameter range from about 0.25 mm to about 1 cm is preferred for direct, non-mix tank applied fibers. The fibers in the nets prepared by jet attenuated spinning typically have diameters ranging from about 1 to about 100 microns. Larger diameter fibers are prepared by melt co-extrusion techniques from a melt extruder.

The filled fibers fabricated into nets have a minimum tensile strength of 0.05 $N/m/g/m^2$. Net tensile strength is measured by cutting a 12.7 cm square

sample of the net and weighing it to give the basis weight. The sample is then mounted in an Instron tensile tester available from Instron Company, 100 Royall Street, Canton, MA 02021, and the force and extension required for breakage is determined through a Computer Aided Tensile Testing System (CATTS) data acquisition system.

$$\text{Tensile strength } (N/m/g/m^2) = \frac{\text{load at maximum force (N)}}{\text{basis weight } (g/m^2) \times \text{width (m)}}$$

Nets of the present invention can also be prepared from filled films by creating a plurality of holes such that the void area is greater than or equal to the film area (followed by optional stretching). The nets can be prepared using methods known in the art for puncturing and stretching polymer films (see Encyclopedia of Polymer Science and Engineering, Volume 6, John Wiley & Sons, New York, pp 375-377; and Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed., Vol. 16, John Wiley & Sons, New York; pp 833-834). The film may be perforated by a knife, needle, or pin roller. The punctured film may then be drawn uniaxially by conventional means. Filled films are prepared as in U.S. 3,299,506 and British Patent 2,095,558. Each of these patents discloses a water-soluble polymer containing a uniformly dispersed chemical in the form of a thin flat film which can be torn or cut into measured sections for delivery of the chemical contained in the water-soluble polymer.

The water-soluble filled film is made by dissolving the polymer being used in water followed by addition of and mixing of the agricultural chemical therewith and removal of water to form a solid polymer film with agricultural chemical dispersed therein. If the chemical is a liquid, it can be added directly to the dissolved polymer. The combination results in an oil-in-water emulsion. A low-melting waxy solid agricultural chemical is heated above its melting point and added to the polymer solution. A powder can be added directly to the polymer solution or by making a slurry in water and adding it to the polymer solution. The combination results in a dispersion. The mixture of dissolved polymer and agricultural chemical is cast into a film.

The resultant water-soluble film may contain from 1-65% of an agricultural chemical based on the weight of polymer plus agricultural chemical, to provide the amount of chemical desired for particular application.

The fibers, ropes or nets for releasing the active ingredient in a mix tank or for application over the crop dissolve in water in ten minutes or less, preferably 5 minutes or less. Fibers, ropes, and nets intended for other applications (i.e., to be layed in furrows), dissolve in 30 minutes or less. Dissolution is measured by adding a 15 mm length fiber or rope, or a 15 mm square net, to a 100 mL graduated cylinder (internal height after stoppering is 22.5 cm, internal diameter is 28 mm) containing 90 mL of distilled water at 25°C. The cylinder is clamped in the center, stoppered, and rotated about the center at 8 rpm until the sample is completely dissolved in the water.

The agricultural formulations of the present invention possess a number of advantages over conventional agricultural formulations. For example, the fibers:

a) reduce worker exposure to potentially harmful active ingredients (e.g., pesticides) relative to conventional powder, granule, liquid and gel formulations;

b) allow for easy measurement and application of the proper active ingredient dosage;

c) eliminate runoff from excess application;

d) provide faster release of the active ingredient than filled films or water-soluble bags in a mix tank;

e) allow for the incorporation of incompatible active ingredients in the same formulation;

f) eliminate disposal problems associated with contaminated packages of conventional formulations; and

g) in some embodiments, do not contaminate a mix tank, reduce spray drift, and target only the locus to be protected and thereby reduce waste.

The following Examples illustrate the present invention and are not intended as limiting.

EXAMPLE 1

Preparation of a Water-Soluble Net Comprising Metsulfuron Methyl

100 Grams of a solution containing, 31.50% polyvinyl alcohol (PVA 51-05, DuPont Elvanol®, which has a viscosity of 5.5 x 10^{-6} Pa·s of a 4% aqueous solution at 20 °C. as determined using the Hoeppler Falling Ball Method, ASTM 1343-56, Part 8, 1958, p 486), 13.5% metsulfuron methyl herbicide, and 55% water was poured inside the barrels of a twin-cell which was connected through a valve to a jet attenuated spin (JAS) cell of the type disclosed in U.S. Patent

4,963,298. The JAS cell contained (1) a spinneret for the extrusion of the polymer solution having a capillary diameter of 0.025 cm and an length to diameter (L/D) ratio of 3.0, and (2) a converging air-jet nozzle having a throat diameter of 0.318 cm placed concentric to the spinneret for the flow of a high velocity air stream. The spacing between the tip of the spinneret and the tip of the converging air-jet was maintained at 0.447 cm.

A primary stream of air, heated to 408 °C. under a pressure of 5.15 x 10^5 Pa flowed through the annulus between the spinneret body and the converging air-jet and exited with a velocity of about 194 m/s. The fibers extruding through the spinneret were exposed to high velocity, high temperature air for less than one second, and were partially dried and attenuated to low denier fibers. A denier is defined as the weight in grams of a fiber of 9000 meter length After exiting the JAS cell the fibers were exposed to a secondary stream of high temperature (408 °C.) air under a supply pressure of 7.22 x 10^5 Pa and flowing through a distribution plate with 10 holes each having a diameter of 0.102 cm, at a velocity of 481 m/s and equal to the velocity of sound in air under the conditions of the experiment. The contact time of the fibers with the secondary high temperature, high velocity air was also less than one second.

The discontinuous fibers were collected in the form of a bonded net. The bonding was achieved by the residual water in the fiber stream. A scanning electron micrograph showing the net is given in Figure 4. The net dissolved in water in 2 minutes and had a tensile strength of 0.05 N/m/g/m^2.

EXAMPLE 2

A starting aqueous solution containing 30.0% PVA (as used in Example 1), 20.0% metsulfuron methyl herbicide, 4.5% polyoxyethylene binder, and 45.5% water was treated as in Example 1.

The net was prepared using the same procedure using primary air at 428 °C. and secondary air at 419 °C. The exposure time remained the same as in Example 1. The net dissolved in water in 3 minutes and had a tensile strength of 0.05 N/m/g/m^2.

What is claimed is:

1. An agricultural composition comprising at least one water-soluble polymeric fiber wherein at least one agriculturally active ingredient is uniformly dispersed or dissolved within the fiber.

2. An agricultural composition comprising at least one water-soluble polymeric fiber in the form of a polymeric sheath of at least one layer surrounding a core comprising an agriculturally active ingredient.

3. An agricultural composition of Claim 3 further comprising at least one agriculturally active ingredient contained within the polymeric sheath.

4. An agricultural composition of Claim 4 wherein the polymeric sheath comprises multiple layers, each said layer containing at least one active ingredient.

5. An agricultural composition of Claim 1 or 2 wherein two or more fibers are configured in the form of a rope.

6. The rope of Claim 5 wherein each fiber contains a distinct active ingredient.

7. The rope of Claim 5 wherein at least one fiber contains air.

8. An agricultural composition of Claim 1 or 2 wherein one or more fibers are configured in the form of a net.

9. The net of Claim 8 wherein multiple agriculturally active ingredients are present.

10. The net of Claim 8 wherein at least one fiber contains air.

FIG.1

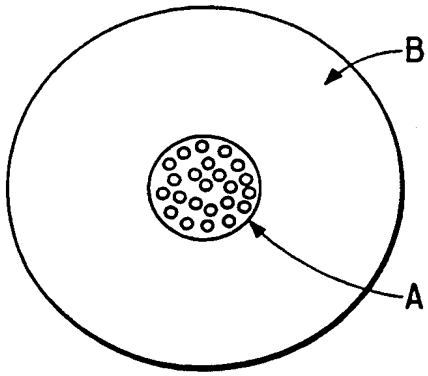
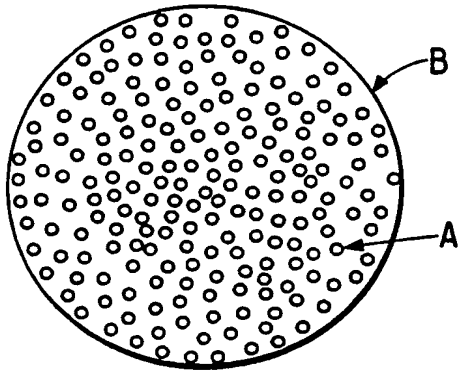


FIG.2



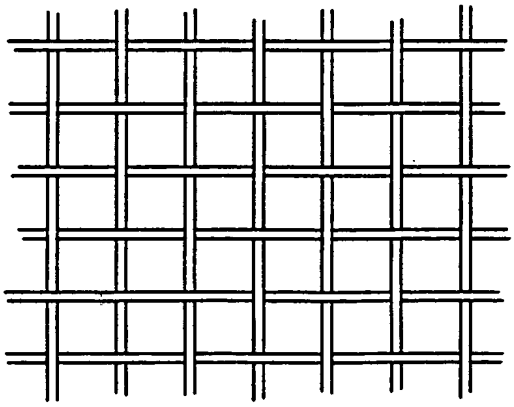


FIG.3A

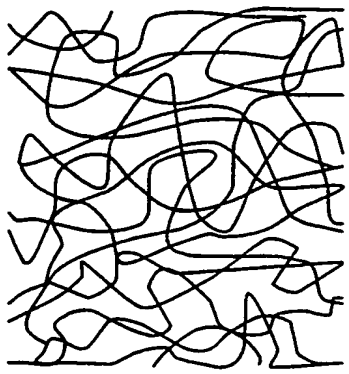
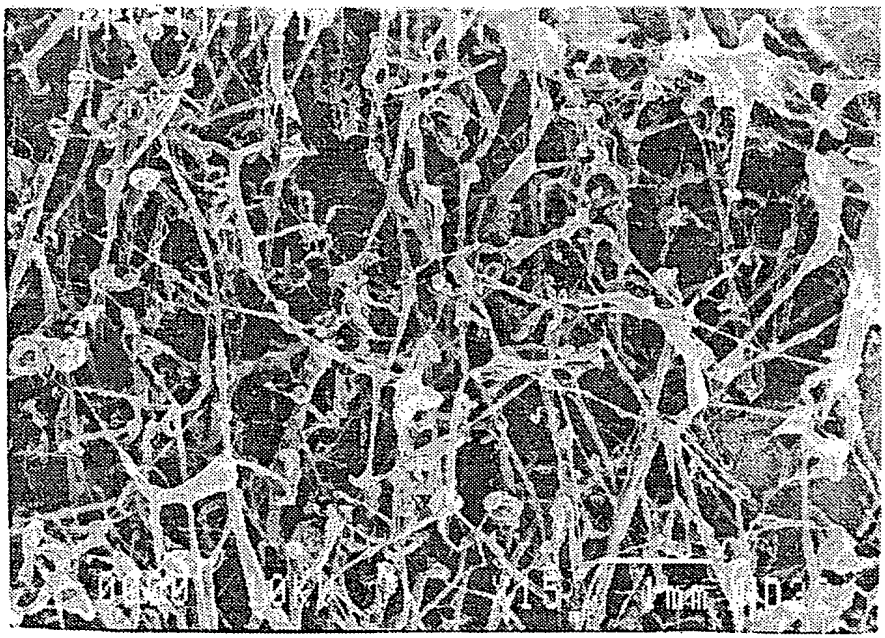


FIG.3B

FIG.4



INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/US 94/02555

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 A01N25/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,3 299 566 (C.W.MACMULLEN) 24 January 1967 cited in the application see column 1, line 15 - column 1, line 50	1,8
A	GB,A,2 095 558 (AVON PACKERS LTD) 6 October 1982 cited in the application	
A	WO,A,89 01284 (BATTELLE MEMORIAL INSTITUTE) 23 February 1989 cited in the application	
A	WO,A,91 01086 (R.W.WILSON) 7 February 1991	

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 August 1994	23. 08. 94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Donovan, T

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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CENTRAL PATENTS INDEX, BASIC ABSTRACTS JOURNAL Section Ch, Week 7802, Derwent Publications Ltd., London, GB; Class C, AN 03508A & JP,A,77 049 049 (NOHON NOYAKU KK) ---	
A	EP,A,0 381 206 (E.I. DU PONT DE NEMOURS AND COMPANY) 8 August 1990 ---	
A	H.F.MARK (ED.) 'Encyclopedia of polymer science and technology' 1987 , JOHN WILEY & SONS , NEW YORK, US cited in the application see page 833 - page 834 ---	1-10
A	H.F.MARK (ED.) ET. AL. 'Kirk-Othmer encyclopedia of chemical technology' 1989 , JOHN WILEY & SONS , NEW YORK, US cited in the application see page 375 - page 377 -----	1-10

INTERNATIONAL SEARCH REPORT

...rmation on patent family members

Intern...al Application No
...T/US 94/02555

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WO-A-9101086	07-02-91	NONE		
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